IN VITRO PERFORMANCE OF STANNOUS FLUORIDE PROPHYLAXIS PASTE AND TOPICAL SOLUTION - ALONE AND IN COMBINATION

TECHNICAL DOCUMENTARY REPORT NO. SAM-TDR-62-126

November 1962

USAF School of Aerospace Medicine
Aerospace Medical Division (AFSC)
Brooks Air Force Base, Texas

Project No. 7756, Task No. 59713

FOREWORD

This report was prepared by the following personnel in the Experimental Dentistry Department:

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The authors express appreciation to Airmen J. F. McAnear, E. D. Dinger, H. C. LeFlore, and V. N. Moore for technical assistance.

ABSTRACT

A comparison was made of the in vitro effectiveness of three methods of stannous fluoride application in reducing enamel solubility: (1) X-6 prophylaxis paste alone, (2) 10 percent aqueous stannous fluoride topical solution alone, (3) combined X-6 prophylaxis paste and 10 percent aqueous stannous fluoride topical solution.

The results obtained with the X-6 prophylaxis paste alone and the 10 percent aqueous stannous fluoride topical solution alone were found not to differ statistically.

The treatment combining X-6 prophylaxis paste and 10 percent aqueous stannous fluoride topical treatment was found to be more effective than the X-6 prophylaxis paste when each was prepared with solutions 1, 2, and 4 weeks of age. Combined application was also more effective than the 10 percent aqueous stannous fluoride topical treatment alone when each was prepared with solutions 1, 2, 8, and 22 weeks of age.

Treatment reduced enamel solubility by over 75 percent in all experimental groups and there was no loss of effectiveness when the constituent stannous fluoride solutions were aged over a 22-week period.

This technical documentary report has been reviewed and is approved.

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1. INTRODUCTION

Both clinical and laboratory research have indicated the value of the topical application of stannous fluoride in a preventive dentistry program. The original observation by Muhler and Van Huysen (1) that this compound was more effective than sodium fluoride stands as a milestone in preventive dentistry research.

For very obvious clinical reasons several attempts have been made to incorporate stannous fluoride in a prophylaxis paste. Segreto et al. (2) developed and evaluated a silex-silicone prophylaxis paste containing approximately 20 percent stannous fluoride by weight. This high concentration of active ingredient demanded very careful use by the clinician and produced an unacceptable number of clinical complications. The performance of this formulation has been questioned by Wachtel (3). In previous laboratory studies it has been shown that a very effective paste resulted when the silex and silicone were omitted from the formulation, and ion-exchange water was substituted therefor (4). Additional experiments pointed out that much lower concentrations of stannous fluoride were effective in topical applications (5) and in aqueous prophylaxis pastes (6).

The topical application of stannous fluoride is an integral portion of the U.S. Air Force Preventive Dentistry Program. To combine the value of topical application with that of prophylaxis paste, a stable stannous fluoride solution was required that could be employed alone as a topical application and, when added to a flavored abrasive, could be used as a prophylaxis paste. The present study was concerned with the evaluation of such a paste and aqueous solution, singly and in combination.

Received for publication on 7 August 1962.

2. MATERIALS AND METHODS

Extracted human molars and bicuspids were cleaned thoroughly and refrigerated in ion-exchange water until used. Grooves, fissures, enamel discontinuities, and root surfaces were covered with molten, sticky wax. The remaining intact enamel was exposed to two consecutive 30-minute decalcification periods in 0.025 molar lactic acid with the fluoride treatment under test being applied in the interval between the decalcification periods. Thus, for each tooth two acid solutions were available for analysis, one for the period before and one for the period after treatment. The phosphorous content of the acid solutions was measured automatically by the method of Fiske-Subbarow (7) as adapted to the AutoAnalyzer. The difference in the amounts of phosphorus withdrawn from the enamel surface before and after fluoride treatment was taken as a measure of the protection afforded by the treatment. Tooth preparation, acid exposure method, and the performance of the analytic procedure have been presented in detail elsewhere (4).

The present study was divided into three related experiments with a total of 390 teeth being tested:

1. A 10 percent aqueous stannous fluoride solution was added to flavored silex to prepare the X-6 prophylaxis paste. It has been previously determined (6) that this procedure provided a paste with a stannous fluoride concentration of approximately 2 percent by

TABLE I

*Means + S.D. for protection afforded by various application methods**

Age of SnF_2 solution	Type of treatment		
	X-6 prophylaxis paste	10 percent SnF_2 topical solution	X-6 paste + 10 percent topical solution
Fresh	75.2 ± 14.22	78.3 ± 8.46	82.0 ± 7.38
1 week	75.9 ± 8.24	77.4 ± 8.07	90.0 ± 2.40
2 weeks	85.6 ± 5.99	83.7 ± 8.17	89.4 ± 3.62
4 weeks	84.2 ± 6.66	78.2 ± 11.74	90.3 ± 4.10
8 weeks	84.2 ± 10.28	77.2 ± 11.32	87.5 ± 5.37
22 weeks	81.6 ± 9.12	76.2 ± 9.86	86.9 ± 6.47

*Based on phosphorus withdrawn by acid before and after treatment.

weight. This paste was applied to the crown surface in a rubber cup turning at 1,100 r.p.m. over a 1-minute period. Pastes were prepared and evaluated on 145 teeth when the aqueous solution was fresh and at age intervals of 1, 2, 4, 8, and 22 weeks.

2. A portion of the 10 percent aqueous stannous fluoride solution was tested on 100 teeth as a 4-minute topical treatment. This solution was tested at the same time intervals as the X-6 paste.

3. A 1-minute prophylaxis with X-6 paste was followed by a 4-minute topical application of 10 percent aqueous stannous fluoride on an additional 145 teeth. The continuity of the age intervals was maintained.

3. RESULTS AND DISCUSSION

It is to be emphasized that the age intervals in the present study refer only to the age of the aqueous stannous fluoride solution. Since fresh mixtures of the solution with abrasive were prepared at each testing interval, the compatibility of stannous fluoride with the abrasive was not a consideration. A previous report from this laboratory has dealt with the incompatibility of calcium pyrophosphate and an aqueous stannous fluoride solution (8).

The results obtained with the three fluoride application procedures under test are outlined in table I. Findings are expressed as mean percent protection and are based on differences in the amount of phosphorus lost by crown surfaces before and after treatment.

The mean percent protection afforded by the X-6 prophylaxis paste alone ranged from a low of 75.2 (S.D. ± 14.22) to a high of 85.6 (S.D. ± 5.99). The X-6 prophylaxis pastes prepared with both the 2-week and 4-week-old fluoride solutions were significantly ($P < .01$) more effective than that prepared with the fresh solution. The pastes prepared with the 2-, 4-, and 8-week-old fluoride solutions were significantly ($P < .01$) more effective than that prepared with 1-week-old solution.

The mean percent protection provided by the 4-minute, 10 percent stannous fluoride topical solution alone ranged from 76.2 (S.D. ± 9.86) to 83.7 (S.D. ± 8.17). No significant differences were noted in the amount of protection afforded by solutions of different ages.

The X-6 prophylaxis paste followed by the 4-minute, 10 percent aqueous stannous fluoride topical solution resulted in protection ranging from 82.0 (S.D. ± 7.38) to 90.3 (S.D. ± 4.10) percent. The fresh fluoride solution was significantly ($P < .01$) less effective than the 1-, 2-, and 4-week-old solutions when employed in this combined approach.

In comparing the methods of application, no highly significant differences were found at any age interval between the results for the X-6 paste alone and for the topical application alone. At one interval a paste superiority of borderline significance ($P < .05$) was found but this was held due to chance, since no other age differences were discernible.

The performance of the combined X-6 paste and the 10 percent topical solution was significantly better than that of the 10 percent topical solution alone. At age intervals of 1, 2, 4, 8, and 22 weeks, this superiority was significant at the .01 level.

With solutions aged 1 week and 4 weeks, the combined X-6 paste plus the 10 percent topical solution was significantly ($P < .01$) more effective than the paste alone. A similar difference at the .05 level was found at the 2-week age interval.

When freshly prepared solutions were tested, there were no significant differences in effectiveness between the three application procedures.

In two of the three experiments, those in which prophylaxis paste was applied, older solutions were found to be significantly more effective than fresh solutions. This is not a function of the time of exposure of the solution to abrasive since, in all instances, fresh pastes were prepared immediately prior to testing. We have consistently found that fresh stannous fluoride solutions are less effective when employed as paste constituents and, further, that certain of our completely prepared experimental prophylaxis pastes require aging to develop maximum effectiveness. An explanation of these findings is being sought at this time.

It is not to be implied that the topical application of stannous fluoride, even in the patient receiving stannous fluoride prophylaxis, is in any way contraindicated by the results of this study. It is only in the results of topical application that virtually universal agreement of effectiveness is found between clinical and laboratory investigators. The results indicate, on the other hand, that the incorporation of a small amount of stannous fluoride in prophylaxis paste is surprisingly protective and that the combined paste plus topical approach is the treatment of choice. Since prophylaxis is recommended prior to topical application, the dual application of stannous fluoride suggested by these results makes no additional imposition on the clinician's time.

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